The State of CATV in Pennsylvania

Introduction

Pennsylvania, Pittsburgh in particular, has become a laboratory for the development and testing of connected and autonomous vehicle (CATV) technology. A variety of factors working in tandem has enabled Pennsylvania to reach this status. One significant driver of this CATV focus is Carnegie Mellon, a major player in artificial intelligence and engineering, with a long history of autonomous vehicle projects (Fialka, 1985; Shackner, 2018; Templeton, 2008). This helped turn Pittsburgh into a top innovation center for self-driving vehicles, attracting massively funded startups such as Aurora Innovation, Argo AI, and other major industry players (Ganz, 2019; Linder, 2019). Several groundbreaking advancements have come out of Pittsburgh over the past few years, including the first self-driving Uber in 2016 (Uber, 2016.)

As a response, several governmental responses at the local, state assembly, and executive level emerged in order to create new standards, definitions, and allowances for CATV. Together, the prominence of Carnegie Mellon University (CMU), heavy investment, and government cooperation have led to Pennsylvania evolution and development into a key state for CATV research, development, and testing.

Pennsylvania has tackled many of the unique challenges that CATV present, paying varying levels of attention to the Purdue Policy Research Institute's (PPRI) CATV focuses of security, infrastructure, human acceptance and trust, human takeover, safety, and workforce impact. Other areas such as privacy, and ethics in algorithms have been unaddressed by formal policy or initiatives.

Stakeholders

Uber

Pennsylvania was seen as an ideal testing ground when Uber first sought to launch their landmark self-driving car. Uber partnered with the NREC in 2015 to establish the Uber Advanced Technologies Group in order to research "mapping and vehicle safety and autonomy technology," (Uber, 2015).

A year and a half later the first self-driving Uber would reach the streets of Pittsburgh. In addition to CMU, another key factor pushing Uber towards Pennsylvania was the physical features of the state itself. The variety of terrain and weather would allow researchers to explore how autonomous vehicles behave in less than ideal conditions (e.g., hills, curves, inclement weather).

Their experiments were not without falters however, with testing stopping in Pittsburgh for a period following the death of a pedestrian in Arizona struck by a self-driving Uber (Wakabayashi, 2018). Eventually testing resumed with in cooperation with city and state officials.

Figure 1: Uber's self-driving car deployment, (Blazing, 2017).

Other Companies

Other key players in Pennsylvania include Aurora Innovation, Argo AI, and Aptiv Services. Each group has both a high level of investment and authorization to test autonomous vehicles. Aurora Innovation was created by former heads of autonomous projects at Google and Tesla, and aims to, "develop the hardware, software, and data services necessary to build an autonomous driving platform," (Muoio, 2017). Aurora has already attracted $500M in funding from Amazon and Sequoia Capital, a Silicon Valley investment firm, and became Pennsylvania's first licensed autonomous vehicle tester in 2018 (Linder, 2018). Argo AI on the other hand received $1 billion from Ford in 2017 and will receive nearly $2 billion in investment from Volkswagen in order to develop new autonomous technology for them (Ganz, 2019). Less is known about Aptiv's operations in Philadelphia, but their website lists $14.4 billion in revenue (Aptiv, 2019).

According to the Pennsylvania Department of Transportation, the full list of Authorized Testers a includes Aurora Innovation, Qualcomm Technologies, Carnegie Mellon (who uses their licensing in corporate partnerships), Argo AI, Aptiv Services, and Uber Autonomous Technologies Group (PennDOT, 2019).

Definitions

As technology advances, many traditional legal definitions become quickly outdated and unable to cope with the challenges that the technology poses. Pennsylvania has addressed these issues in two main capacities: legislation and through the Pennsylvania Department of Transportation.

HB 1958

As per HB 1958 (NCSL, n.d.): A platoon is, "A group of buses, military vehicles or motor carrier vehicles traveling in a unified manner at electronically coordinated speeds at following distances that are closer than would be reasonable and prudent without the coordination. The term does not include a school bus or a school vehicle.

A highly automated work zone vehicle is, "A motor vehicle used in an active work zone, as implemented by the Department or the Pennsylvania Turnpike Commission, as applicable, which is: (1) equipped with an automated driving system; or (2) connected by wireless communication or other technology to another vehicle allowing for coordinated or controlled movement."

Joint Statewide Connected and Automated Vehicle Strategic Plan

Under the Strategic Plan (PennDOT, 2018): A connected vehicle, "enables safe, interoperable networked wireless communications among vehicles, roadside infrastructure, and others." Vehicle-to-Infrastructure (V2I), "V2I technologies capture(s) vehicle-generated traffic data, wirelessly provid[es] information such as advisories from the infrastructure to the vehicle that inform the driver of safety, mobility, or environment-related conditions. State and local agencies are likely to install V2I infrastructure alongside or integrated with existing ITS equipment."

On Vehicle-to Vehicle, "Vehicle-to-Vehicle (V2V) communications for safety is the wireless exchange of data among vehicles traveling in the same vicinity that offers opportunities for significant safety improvements."

In addition, "Vehicle-to-Everything (V2X) communication is the passing of information from a vehicle to any entity that may affect the vehicle, and vice versa. It is a vehicular communication system that incorporates other more specific types of communication as V2I, V2V, V2P (Vehicle-to-Pedestrian), V2D (Vehicle-to-Device) and V2G (Vehicle-to-Grid)."

Finally, the Strategic Plan adopts the International Society of Automotive Engineer standard definitions on Levels of Driving Automation ranging from 0 (No automation) to 5 (Full Driving Automation.)

Governmental Response

One recurring element in coverage of Pennsylvania's CATV situation is the low level of regulations in the state compared to California. Even after the mayor of Pittsburgh passed down new rules following the autonomous Uber crash in Arizona, companies engaged in vehicle testing expressed their appreciation for the friendly regulatory environment in Pennsylvania (AP, 2019). The city called this executive order "the first of its kind" in any city. Primarily served as a pathway for Uber and other vehicles to regain trust by increasing transparency.

Legislation

In 2016, SB 1267 allocated $40 million in order to support intelligent transportation projects, but did not add any new standards or definitions. Later HB 1958 defined "highly automated work zone vehicles" and created a "Highly Automated Vehicle Advisory Committee" within PennDOT, but mostly concerned platooning vehicles rather than vehicles for public transit (NCSL, n.d.). In addition, several pending bills have proposed new requirements, more specific

definitions of autonomous vehicles and related technologies, new licensing, and other potential regulations, but have yet to be successful. As such, most policy innovation has come from the Pennsylvania Department of Transportation itself.

PennDOT

The Pennsylvania Department of Transportation is particularly engaged in CATV topics and devotes several sections of their website to authorized testers, various initiatives and goals, and frequently asked questions. PennDOT has created a series of plans to prepare the state for increased deployment of autonomous vehicles, as well as to promote the technologies within the state (PennDOT, 2019).

Many of these have come from the Autonomous Vehicle Policy Task Force that was assembled under Pennsylvania HB 1958. After convening, the Task Force took in public comments and worked directly with regulators, other public officials, and private stakeholders to develop policy recommendations (PennDOT, 2016). Some of the more notable recommendations were:

- Testers of highly automated vehicles (HAVs) must submit testing proposals to PennDOT and enter contracts attesting that the vehicles meet all federal and state safety standards and meet the policies adopted by PennDOT.

- PennDOT must be notified prior to any HAV being used without an operator in fully self-driving mode.

- PennDOT and the Pennsylvania Turnpike Commission may temporarily restrict HAVs from certain routes. Otherwise, HAVs may be tested on any road in the state. Municipalities can also ask PennDOT to temporarily restrict HAVs on local routes.

- Platooning of HAVs will be restricted to commercial two- to three-passenger vehicles. However, testers can ask to use more HAVs in platooning, but PennDOT can ask for a safety demonstration first.

- The HAVs must be able to record data that can be used to investigate crashes involving the HAVs. PennDOT will have access to that data.

- Testers must certify that cybersecurity protections are in place for the HAVs.

- PennDOT will collect data on total miles operated by HAVs, total number of hours of operation, and size of HAV fleets. PennDOT may also ask for other information such as counties where HAVs are being tested and percentage of testing done on limited access highways. PennDOT can also ask for information about the economic impact of HAV testing.

- PennDOT and State Police will make annual reports on HAV testing to the Legislature.

Initiatives and Goals

The Connected and Autonomous Vehicle 2040 Vision

The 2040 Vision project was the original roadmap for the State of Pennsylvania on Connected and Autonomous Vehicles, and predates the Autonomous Vehicle Policy Task Force by three years (PennDOT, 2014).

Working with CMU researchers, PennDOT explored the numerous issues facing the integration of CATV in a report published in July of 2014, and provided suggestions for how to navigate this process including a projected timeline for future advancements looking forward to 2040.

Pennsylvania Joint Statewide Connected and Autonomous Vehicles Strategic Plan

An update on CATV priorities and strategies was introduced in 2018 with the Pennsylvania Joint Statewide Connected and Autonomous Vehicles Strategic Plan (PennDOT, 2018). This Strategic Plan is described as a "living document" that will both serve as a clear demonstration of PennDOT's policy goals and allow changes as the research and technology continues to develop.

The nine key areas that the Strategic Plan covers are "Maintenance and Operations, Design and Construction, Planning and Research, Information Technology and Security, Driver Licensing and Motor Vehicles, Modal Considerations, Policy and Legal, Outreach and Collaboration, and Workforce Requirements."

The goals are stated as "Improve Safety, Enhance Mobility, Prepare Workforce, Foster and Sustain Partnerships, Increase Public Awareness of Benefits and Risks, and Support Economic Competitiveness."

PennStart Test Track

The PennStart Test Track is a future facility planned for testing autonomous vehicles to handle different road conditions and infrastructure challenges (PennDOT, 2019).

This plan is in in early stages, with no location or final design chosen, but PennDOT indicates a 2020 operational date. This facility aims to tackle safety issues in

"traffic incident management (TIM); tolling and intelligent transportation systems (ITS) technology; work zones; commercial vehicles; transit vehicles; and connected and automated vehicles."

Figure 2: The PennStart Test Track, (PennDOT, 2019).

The Smart Belt Coalition

The Smart Belt Coalition is a collaborative project between PennDOT, the Pennsylvania Turnpike Commission, Ohio DOT, the Ohio Turnpike, and Michigan DOT (PennDOT, 2019).

This project aims to pool knowledge and resources among the states' transportation agencies and their universities to advance research and policy. The hope for the Smart Belt Coalition is that their diverse set of roads working through both cities and rural areas will provide an excellent arena for testing and deployment.

Figure 3: The Smart Belt Coalition logo highlighting the various stakeholders, (PennDOT, 2019).